LA-UR-18-31855
Approved for public release; distribution is unlimited.

Title: Counts in the ORTEC Detective X neutron channel

Author(s): Rees, Brian G.
Walker, Doug
Giles, John
Oertel, Christopher
Rolfe, Kevin

Intended for: Public release to a variety of people who use the instrument

Issued: 2018-12-20

Counts in the ORTEC Detective X neutron channel

Brian Rees, Los Alamos National Laboratory
Doug Walker, John Giles, Christopher Oertel, Idaho National Laboratory
Kevin Rolfe, Sandia National Laboratory

Background

The ORTEC Detective X is a new radiation detector being produced and sold by AMTEK ORTEC. The main detector (for gamma radiation energy) is a High Purity Germanium (HPGe) crystal. A Geiger-Müller (GM) tube is used for radiation exposure measurements above about 2 mR/hr. As an available option, a Li^6F/ZnS neutron detector module can be attached to the Detective X to measure neutrons.

Previous ORTEC models have used He^3 gas-filled tubes to measure neutrons. An advantage to using He^3 gas for neutron detection is that it is relatively insensitive to gamma radiation causing counts in the neutron channel. It has been noted that Li loaded glass scintillators have a low relative light output, and suffer gamma interference because of the imprecise discrimination ability against gamma sources (Knoll, 2000).

Since there is a potential for gamma radiation to cause counts in the Li^6F neutron detector that the Detective X uses, measurements were taken with a small variety of gamma-ray sources to investigate the detector's response.

Measurements

A range of gamma ray energies was tested by using Am-241, Ba-133m, Cs-137, and Co-60. Adequate activity was used to enable source placement at least 6" from the detector face to minimize shadowing of the neutron detector by the HPGe crystal.

An instrument Dead Time (DT) of approximately 68% was used for most of the measurements. The Detective X does not allow spectral collection above 70% dead time, so approximately 68% was selected as a high-end of likely spectra collected for submissions. One spectrum was collected with Co-60 at an 85% DT by starting the collection at less than 70% DT and then moving the source closer to the detector. This was only done with Co-60 because the light pulse from the neutron-induced reaction products in a Li loaded glass scintillator is about the same as a 1.2 MeV gamma ray (Knoll, 2000).

Background measurements were taken prior to and after testing to ensure that sources hadn't been moved in the area to affect background.

All measurements were performed for 30 minutes clock time.

The total neutron counts were obtained from the N42 data file.

Measurements were conducted without moving the Detective X.

The Detective X uses an algorithm to adjust (i.e., reduce) the number of neutron counts reported when in the presence of a gamma source, so one set of measurements was performed with a Cf-252 source that was well shielded with lead – 2" between the source and detector, and 1" of lead on other sides to reduce scattered gammas.

Filename	Live Time (s)	Dead Time	Gamma counts	Gamma Count Rate	Clock time (s)	Neutron Counts	Neutron Count Rate		
38_410	1785	0.87%	452171	253	1801	571	0.317		bkgd
11_580	266.1	84.81%	15779502	59308	1752	567	0.324		Co-60
44_250	576.4	67.99%	19691300	34160	1801	566	0.314		Co-60
18_170	581.1	67.73%	19942298	34317	1801	544	0.302		Cs-137
52_200	581.3	67.72%	21226099	36514	1801	581	0.323		Ba-133
33_490	573.3	68.16%	23971583	41816	1800	582	0.323		Am-241
37_380	1784.9	0.88%	455190	255	1801	585	0.325		bkgd
11_030	1781.4	1.07%	551160	309	1801	17655	9.8		2" Pb shielded Cf-252 source
54_280	598.7	66.75%	19927587	33285	1801	16964	9.42		2" Pb shielded Cf-252 source and Cs-137

Table 1. Measurement data

Measurement conclusions

The conclusion from this data is that gamma radiation does not result in a net increase in reported counts in the neutron channel.

There is a reduction of reported neutron counts when a gamma (Cs-137) source is introduced. This reduction may be due to a slight over compensation of the Detective X "gamma-correction" algorithm.

X-Ray generator interference

Since this data was taken it has come to light from two different RAP teams that a (Golden[1]) X-ray generator was operating during other measurements observed by field teams that resulted in neutron counts being produced when a neutron source was not present. These measurements were not structured, and need to be repeated in a controlled manner.

[1] Golden Engineering, Inc., Centerville, IN

A Golden X-ray generator has a spark gap that controls the X-ray high voltage pulse generation. This electrical pulse has a tremendous amount of power for a very short duration, and will generate significant RF energy when it discharges (every pulse). Some radiation detectors have shown susceptibility to RF, and this detector may be another one. Distance, orientation of the detector to the generator, and radiation level may be factors in the susceptibility.

Testing was performed with a variety of neutron, gamma, and a Golden x-ray source the week of December 3rd, 2018 at Idaho National Laboratory (RAP 6). These measurements showed counts in the neutron channel during measurements when the Golden was operating at some, but not all orientations to the Detective X, at a distance of approximately 10 feet.

Light Leaks

It has also been reported by Sandia National Laboratory (RAP 4) that light leaks in the neutron detector housing can cause false neutron counts.

Further work

To fully understand the phenomena observed, measurements should be taken with a variety of neutron and gamma ray sources and dead times to characterize the reduction of actual neutron counts when a gamma source is present. Measurements should be taken with a Golden X-ray generator at various angles and distances from the Detective-X.

Knoll, Glenn F. Radiation Detection and Measurement, 2000. P. 548